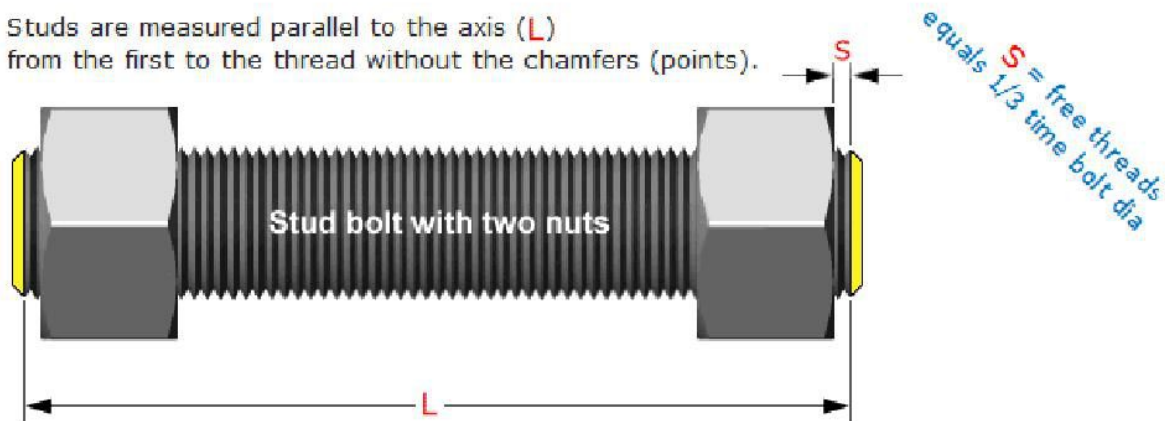


FLANGED JOINTS

STUD BOLTS WITH NUTS:

The Stud Bolt is a threaded rod with 02 heavy hexagon nuts & are essential components of flanged joints as they are key to seal flanged joints properly.

Studs are measured parallel to the axis (L) from the first to the thread without the chamfers (points).



The quantity of bolts for a flange connection will be given by the number of bolt holes in a flange, diameter and length of bolts is dependent of flange type and Pressure Class of flange.

Stud Bolt length are defined in ASME B16.5 standard. The length in inches is equal to the effective thread length measured parallel to the axis, from the first to the first thread without the chamfers (points). First thread is defined as the intersection of the major diameter of the thread with the base of the point.

Notes:

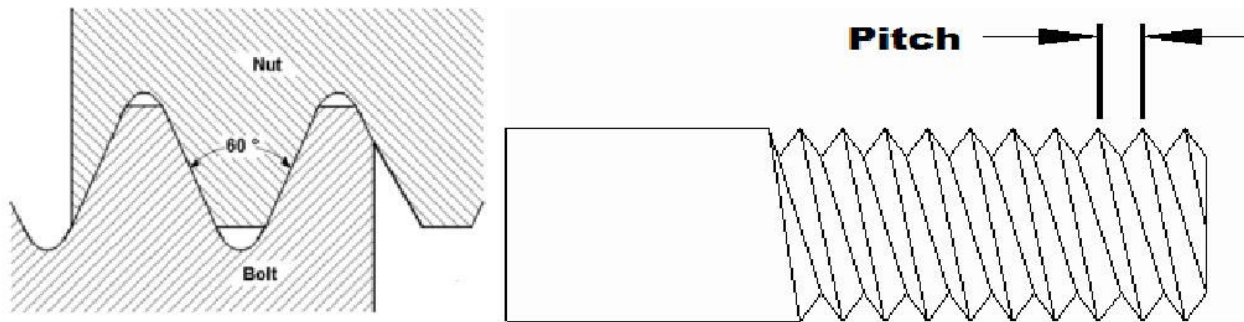
- The length of metric Stud Bolts measured parallel to axis, is the distance from each Stud Bolt, including the point.
- To allow the use of hydraulic tensioning equipment, larger dimension studs shall be often one diameter longer than "standard". That bolts to have plastic end cap protection.

Threads of Stud Bolts:

Bolts threading are defined in ASME B1.1 -2A Unified Inch Screw Threads,

The most common thread is a symmetrical form with a V-profile with included angle is 60° .

This form is widely used in the Unified thread (UN, UNC, UNF, UNRC, UNRF) form as the ISO / metric threads.

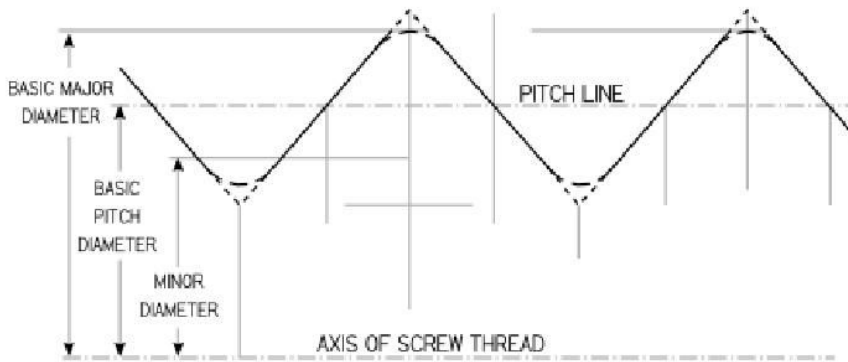


The advantage of a symmetrical threads is that they are easier to produce and inspect compared with non-symmetrical threads. These are typically used in general-purpose fasteners.

Thread series cover designations of diameter/pitch combinations that are measured by the number of threads per inch (TPI) applied to a single diameter.

STANDARD THREAD PITCHES: Thread series cover designations of diameter/pitch combinations that are measured by the number of threads per inch (TPI) applied to a single diameter

- **Coarse thread series (UNC/UNRC):** UNC is the most common type for screws, bolts, and nuts. Coarse threads are used for threads in low strength materials such as iron, mild steel, copper and softer alloy, aluminum, etc. The coarse thread is also more tolerant of adverse conditions and it facilitates quick assembly.,
- **Fine thread series (UNF/UNRF):** UNF is widely used for precision application and when higher tensile strength is required (vs. the coarse thread series) Because of the larger tensile stress areas, However, a longer engagement is required for fine thread applications than for coarse series threads to prevent stripping
- **8 – Thread Series (8UN)** is the specified thread forming method for several ASTM standards including A193 B7, A193 B8/B8M, and A320. This series is used for diameters one inch and above.



Thread Pitch Chart

Coarse Thread Series - UNC

Fine Thread Series - UNF

8-Thread Series - 8UN

Nominal Size and Threads Per In.	Basic Pitch Dia. In.	Section at Minor Dia. Sq in.	Tensile Stress Area Sq in.	Nominal Size and Threads Per In.	Basic Pitch Dia. In.	Section at Minor Dia. Sq in.	Tensile Stress Area Sq in.	Nominal Size and Threads Per In.	Basic Pitch Dia. In.	Section at Minor Dia. Sq in.	Tensile Stress Area Sq in.
$3/8$ - 16	0.3344	0.0678	0.0775	$3/8$ - 24	0.3479	0.0809	0.0878	-- --	--	--	--
$7/16$ - 14	0.3911	0.0933	0.1063	$7/16$ - 20	0.4050	0.1090	0.1187	-- --	--	--	--
$1/2$ - 13	0.4500	0.1257	0.1419	$1/2$ - 20	0.4675	0.1486	0.1599	-- --	--	--	--
$9/16$ - 12	0.5084	0.162	0.182	$9/16$ - 18	0.5264	0.189	0.203	-- --	--	--	--
$5/8$ - 11	0.5660	0.202	0.226	$5/8$ - 18	0.5889	0.240	0.256	-- --	--	--	--
$3/4$ - 10	0.6850	0.302	0.334	$3/4$ - 16	0.7094	0.351	0.373	-- --	--	--	--
$7/8$ - 9	0.8028	0.419	0.462	$7/8$ - 14	0.8286	0.480	0.509	-- --	--	--	--
1 - 8	0.9188	0.551	0.606	1 - 12	0.9459	0.625	0.663	1 - 8	0.9188	0.551	0.606
$1\ 1/8$ - 7	1.0322	0.693	0.763	$1\ 1/8$ - 12	1.0709	0.812	0.856	$1\ 1/8$ - 8	1.0438	0.728	0.790
$1\ 1/4$ - 7	1.1572	0.890	0.969	$1\ 1/4$ - 12	1.1959	1.024	1.073	$1\ 1/4$ - 8	1.1688	0.929	1.000
$1\ 3/8$ - 6	1.2667	1.054	1.155	$1\ 3/8$ - 12	1.3209	1.260	1.315	$1\ 3/8$ - 8	1.2938	1.155	1.233

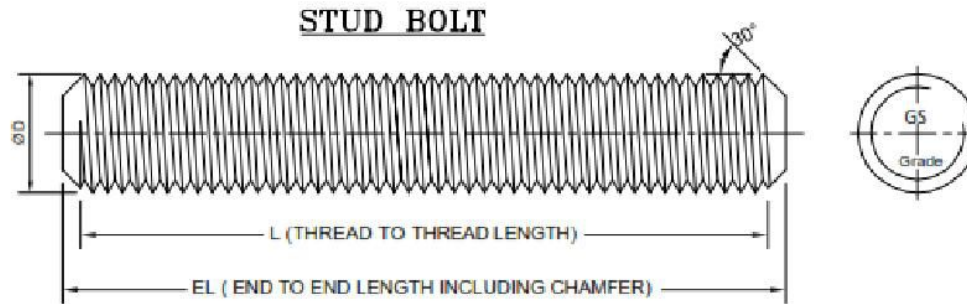
Coarse Thread Series - UNC				Fine Thread Series - UNF				8-Thread Series - 8UN			
Nominal Size and Threads Per In.	Basic Pitch Dia. In.	Section at Minor Dia. Sq in.	Tensile Stress Area Sq in.	Nominal Size and Threads Per In.	Basic Pitch Dia. In.	Section at Minor Dia. Sq in.	Tensile Stress Area Sq in.	Nominal Size and Threads Per In.	Basic Pitch Dia. In.	Section at Minor Dia. Sq in.	Tensile Stress Area Sq in.
1½ - 6	1.3917	1.294	1.405	1½ - 12	1.4459	1.521	1.581	1½ - 8	1.4188	1.405	1.492
-- --	--	--	--	-- --	--	--	--	1⅝ - 8	1.5438	1.68	1.78
1¾ - 5	1.6201	1.74	1.90	-- --	--	--	--	1¾ - 8	1.6688	1.98	2.08
-- --	--	--	--	-- --	--	--	--	1⅞ - 8	1.7938	2.30	2.41
2 - 4½	1.8557	2.30	2.50	-- --	--	--	--	2 - 8	1.9188	2.65	2.77
2¼ - 4½	2.1057	3.02	3.25	-- --	--	--	--	2¼ - 8	2.1688	3.42	3.56
2½ - 4	2.3376	3.72	4.00	-- --	--	--	--	2½ - 8	2.4188	4.29	4.44
2¾ - 4	2.5876	4.62	4.93	-- --	--	--	--	2¾ - 8	2.6688	5.26	5.43
3 - 4	2.8376	5.62	5.97	-- --	--	--	--	3 - 8	2.9188	6.32	6.51
3¼ - 4	3.0876	6.72	7.10	-- --	--	--	--	3¼ - 8	3.1688	7.49	7.69
3½ - 4	3.3376	7.92	8.33	-- --	--	--	--	3½ - 8	3.4188	8.75	8.96
3¾ - 4	3.5876	9.21	9.66	-- --	--	--	--	3¾ - 8	3.6688	10.11	10.34
4 - 4	3.8376	10.61	11.08	-- --	--	--	--	4 - 8	3.9188	11.57	

Stud bolt length:

The length of the stud can be measured either as overall length (EL) or as “first useable thread to first useable thread” FTF or Thread to thread.

The FTF length can be calculated by subtracting a quarter of an inch to the EL length, and it the standard stud length measurement for piping applications.

Flanges of different diameter and rating require stud of different lengths and diameters.



LENGTH.(mm) (THREAD TO THREAD)	END TO END LENGTH TOLERANCE	
	EL (Min)	EL (Max)
$L \leq 12"$ (305mm)	$L +6.35\text{mm}$	EL (Min) $+1.57\text{mm}$
$L >12" \leq 18"$ (305 to 457)	$L +6.35\text{mm}$	EL (Min) $+3.18\text{mm}$
$L >18"$ (1>457)	$L +6.35\text{mm}$	EL (Min) $+6.35\text{mm}$

Fig. 1 Relationship of Dimensions, L and U , on Flange Bolting Studs (Stud Bolts)

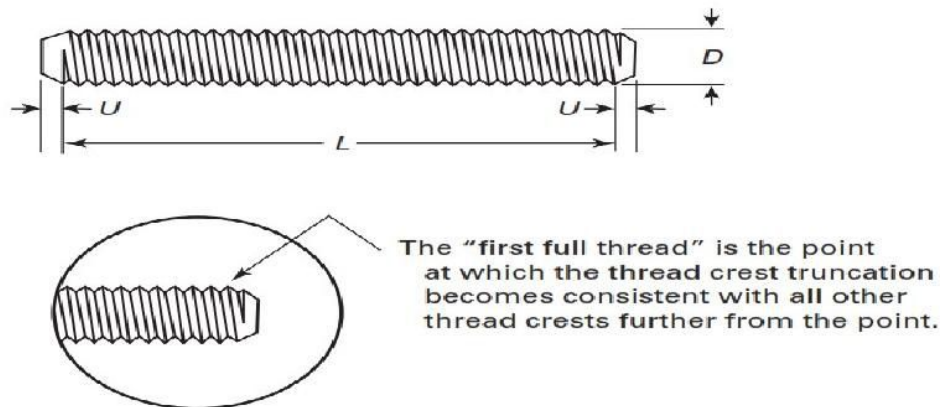
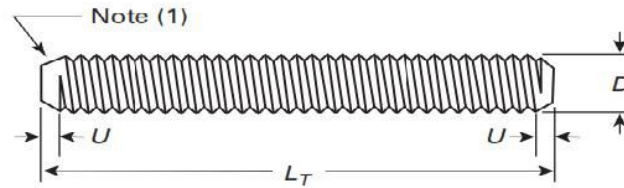


Table 1 Dimensions for Continuous Thread Studs



Nominal Size	Diameter, D	Threads Per Inch [Note (2)]		Chamfered Thread Distance, U							
				UNC Threads			UNF Threads		8UN Threads		
				UNC	UNF	8UN	Min.	Max.	Min.	Max.	Min.	Max.
1/4	0.2500	20	28	...	0.050	0.100	0.036	0.071	...	...
5/16	0.3125	18	24	...	0.056	0.111	0.042	0.083	...	...
3/8	0.3750	16	24	...	0.063	0.125	0.042	0.083	...	...
7/16	0.4375	14	20	...	0.072	0.143	0.050	0.100	...	...
1/2	0.5000	13	20	...	0.077	0.154	0.050	0.100	...	...
9/16 [Note (3)]	0.5625	12	18	...	0.084	0.167	0.056	0.111	...	...
5/8	0.6250	11	18	...	0.091	0.182	0.056	0.111	...	...
3/4	0.7500	10	16	...	0.100	0.200	0.063	0.125	...	...
7/8	0.8750	9	14	...	0.111	0.222	0.072	0.143	...	...
1	1.0000	8	12	...	0.125	0.250	0.084	0.167	...	...
1 1/8	1.1250	7	12	8	0.143	0.286	0.084	0.167	0.125	0.250	
1 1/4	1.2500	7	12	8	0.143	0.286	0.084	0.167	0.125	0.250	
1 3/8	1.3750	6	12	8	0.167	0.333	0.084	0.167	0.125	0.250	
1 1/2	1.5000	6	12	8	0.167	0.333	0.084	0.167	0.125	0.250	
1 5/8	1.6250	...	...	8	...	...	...	...	0.125	0.250
1 3/4	1.7500	5	...	8	0.200	0.400	...	...	0.125	0.250
1 7/8	1.8750	...	...	8	...	...	...	...	0.125	0.250
2	2.0000	4 1/2	...	8	0.222	0.444	...	...	0.125	0.250
2 1/4	2.2500	4 1/2	...	8	0.222	0.444	...	...	0.125	0.250
2 1/2	2.5000	4	...	8	0.250	0.500	...	...	0.125	0.250
2 3/4	2.7500	4	...	8	0.250	0.500	...	...	0.125	0.250
3	3.0000	4	...	8	0.250	0.500	...	...	0.125	0.250
3 1/4	3.2500	4	...	8	0.250	0.500	...	...	0.125	0.250
3 1/2	3.5000	4	...	8	0.250	0.500	...	...	0.125	0.250
3 3/4	3.7500	4	...	8	0.250	0.500	...	...	0.125	0.250
4	4.0000	4	...	8	0.250	0.500	...	...	0.125	0.250

NOTES:

- (1) See section 8 for end requirements.
- (2) See section 7 for requirements on stud lengths.
- (3) Nonpreferred size; not recommended for new design due to limited availability.

ASTM A193 STUD BOLTS (HIGH TEMP or HIGH PRESSURE):

Originally approved in 1936, this specification is heavily utilized in petroleum and chemical construction applications.

The ASTM A193 specification covers alloy-steel and stainless steel stud bolts materials for high temperature or high-pressure service.

ASTM A193 stud bolts are available in national coarse (UNC) thread pitches, generally used in traditional applications, which means that there are 8 threads per inch (“thread per inch”) for rod diameters above 1 inch. B7 is the most common specification grade for stud bolts.



Threaded stud bolt with Nuts .

The most common stud bolts materials covered by ASTM A193 are:

- ASTM A193 B7: Alloy steel, AISI 4140/4142 quenched and tempered
- ASTM A193 B7M: Alloy steel, AISI 4140/4142 quenched and tempered
- ASTM A193 B16: Alloy steel, AISI 4140/4142 (Cr -Mo -Va) quenched and tempered
- ASTM A193 B8: Class 1 Stainless steel, AISI 304, carbide solution treated.
- ASTM A193 B8A
- ASTM A193 B8M: Class 1 Stainless steel, AISI 316, carbide solution treated.
- ASTM A193 B8MA
- ASTM A193 B8T (SS 321)
- ASTM A193 B8cl2: Class 2 Stainless steel, AISI 304, carbide solution treated, strain hardened
- ASTM A193 B8Tcl2
- ASTM A193 B8Mcl2: Class 2 Stainless steel, AISI 316, carbide solution treated, strain hardened

ASTM A193 Chemical Properties

Element	B7/B7M (AISI 4140)	B8 (AISI 304)	B8M (AISI 316)
Carbon	0.38 - 0.48%	0.08% max	0.08% max
Manganese	0.75 - 1.00%	2.00% max	2.00% max
Phosphorus, max	0.035%	0.045%	0.045%
Sulfur, max	0.040%	0.030%	0.030%
Silicon	0.15 - 0.35%	1.00% max	1.00% max
Chromium	0.80 - 1.10%	18.0 - 20.0%	16.0 - 18.0%
Nickel	n/a	8.0 - 11.0%	10.0 - 14.0%
Molybdenum	0.15 - 0.25%	N/A	2.00 - 3.00%

ASTM A 193 Mechanical Properties :

Grade	Size	Tensile ksi, min	Yield, ksi, min	Elong, %, min	RA % min	HBW	HRC
B7	Up to 2-1/2	125	105	16	50	321 max	35 max
	2-5/8 - 4	115	95	16	50		
	4-1/8 - 7	100	75	18	50		
B7M	Up to 4" & under	100	80	18	50	HRB 93	HRB 99 max
B7M	Over 4 " to 7 "	100	75	18	50	HRB 93	HRB 99 max
B8 Class 1	All	75	30	30	50	223 max	35 max
B8M Class 1	All	75	30	30	50	223 max	96 max
B8 Class 2	Up to 3/4	125	100	12	35	321 max	35 max
	7/8 - 1	115	80	15	35		
	1-1/8 - 1-1/4	105	65	20	35		
	1-3/8 - 1-1/2	100	50	28	45		
B8M Class 2	Up to 3/4	110	95	15	45	321 max	35 max
	7/8 - 1	100	80	20	45		
	1-1/8 - 1-1/4	95	65	25	45		
	1-3/8 - 1-1/2	90	50	30	45		

The material chosen for the threaded stud and the hex nuts should be compatible.

Materials for bolting sets shall be selected based on the process's working temperatures, as shown in the table below.

STUD BOLTS MATERIALS	TEMPERATURE °C (°F)	
	MIN.	MAX.
CARBON STEEL	-29 (-20)	300 (572)
A193 B7, L7	-73 (-100)	400 (752)
A193 B7M	-50 (-10)	900 (482)
A193 B8	-200 (-325)	575 (1067)
A193 B16	0 (32)	520 (968)

Note : Gr - B7M is for sour / Corrosive environments (NACE MR 0175)

ASTM A193 Recommended Combination:

Bolt Grade	<u>Nuts</u>	<u>Washers</u>
B7	<u>A194 Grade 2H</u>	<u>F436 TY-1</u>
B7M	<u>A194 Grade 2HM</u>	<u>F436 TY-1</u>
B8 Class 1	<u>A194 Grade 8</u>	SS304
B8M Class 1	<u>A194 Grade 8M</u>	SS316
B8 Class 2	<u>A194 Grade 8</u>	SS304
B8M Class 2	<u>A194 Grade 8M</u>	SS316

Stud bolts can be produced also with “dual certification,” i.e. they conform to multiple sets of ASTM standards (A193 B7 stud bolts can meet the requirements of A320 L7; B8 and B8m stud bolts also typically conform to both A193 and A320).

ASTM A320 (LOW TEMPERATURE SERVICE)

Originally approved in 1948, ASTM A320 specification covers alloy steel and Stainless-Steel stud bolts materials for low temperature service.

Each alloy under ASTM A320 shall conform to prescribed chemical requirements. The material, as represented by the tension specimens, shall conform to specific requirements in terms of tensile strength, yield strength, elongation, and hardness. The stud bolt material shall meet the prescribed impact energy absorption requirements and the target test temperature.

According to the ASTM A320 specification, manufacturers shall execute at least the following mechanical tests on the material: impact test, tension test, and hardness test.

The most common stud bolts materials under ASTM A320 are listed below (low-temperature service):

1. ASTM A320 L7: Alloy steel, AISI 4140/4142 Quenched and tempered
2. ASTM A320 L7M:
3. ASTM A320 L43: Alloy steel, AISI 4340 Quenched and tempered
4. ASTM A320 B8 Class 1: Stainless steel, AISI 304, carbide solution treated
5. ASTM A320 B8A:
6. ASTM A320 B8T:
7. ASTM A320 B8TA:
8. ASTM A320 B8C:
9. ASTM A320 B8M: Class 1 Stainless steel, AISI 316, carbide solution treated
10. ASTM A320 B8MA:
11. ASTM A320 B8cl2: Stainless steel, AISI 304, carbide solution treated, strain hardened
12. ASTM A320 B8Mcl2: Stainless steel, AISI 316, carbide solution treated, strain hardened

ASTM A320 Stud Bolts: Chemical Properties:

Element	L7 (AISI 4140)	L43 (AISI 4340)	B8 (AISI 304)	B8M (AISI 316)
Carbon	0.38 - 0.48%	0.38 - 0.43%	0.08% max	0.08% max
Manganese	0.75 - 1.00%	0.75 - 1.00%	2.00% max	2.00% max
Phosphorus, max	0.035%	0.035%	0.045%	0.045%
Sulfur, max	0.040%	0.040%	0.030%	0.030%
Silicon	0.15 - 0.35%	0.15 - 0.35%	1.00% max	1.00% max
Chromium	0.80 - 1.10%	0.70 - 0.90%	18.0 - 20.0%	16.0 - 18.0%
Nickel		1.65 - 2.00%	8.0 - 11.0%	10.0 - 14.0%
Molybdenum	0.15 - 0.25%	0.20 - 0.30%		2.00 - 3.00%

ASTM A320 Stud Bolts: Mechanical Properties:

Grade	Diameter	Tensile, ksi, min	Yield, ksi, min	Charpy Impact 20-ft-lbf @ temp	Elong, %, min	RA, %, min
L7	Up to 2 ¹ / ₂	125	105	-150° F	16	50
L7M	Up to 2 ¹ / ₂	100	80	-100° F	18	50
Class 1: BC, B8C, B8M, B8P, B8F, B8T, B8LN, B8MLN	All	75	30	N/A	30	50
Class 1A: B8A, B8CA, B8MA, B8PA, B8FA, B8TA, B8LNA, B8MLNA	All	75	30	N/A	30	50

Class 2: B8, B8C, B8P, B8F, B8T	Up to $\frac{3}{4}$	125	100	N/A	12	35
	$\frac{7}{8}$ - 1	115	80	N/A	15	35
	$1\frac{1}{8}$ - $1\frac{1}{4}$	105	65	N/A	20	35
	$1\frac{3}{8}$ - $1\frac{1}{2}$	100	50	N/A	28	45
Class 2: B8M	Up to $\frac{3}{4}$	110	95	N/A	15	45
	$\frac{7}{8}$ - 1	100	80	N/A	20	45
	$1\frac{1}{8}$ - $1\frac{1}{4}$	95	65	N/A	25	45
	$1\frac{3}{8}$ - $1\frac{1}{2}$	90	50	N/A	30	45

ASTM A320 Stud Bolts Recommended Hardware

Grade	Nuts	Washers
L7	<u>A194 Grade 7 or 4</u>	<u>F436</u>
L7M	<u>A194 Grade 7M</u>	<u>F436</u>
B8 Class 1	<u>A194 Grade 8</u>	SS304
B8M Class 1	<u>A194 Grade 8M</u>	SS316
B8 Class 2	<u>A194 Grade 8</u>	SS304
B8M Class 2	<u>A194 Grade 8M</u>	SS316










STUD BOLTS AND NUTS SELECTION (SERVICE vs. GRADE):

DESIGN TEMPERATURE	FLANGE MATERIAL	STUD BOLT	HEAVY HEX STEEL NUTS
-29° to 427°C	ASTM A 105	A 193 Gr. B7	A 194 Gr. 2H
-10 ° to 482 °c	ASTM A105*	A 193 GR-B7M	A 194 Gr.2HM.
-101° to -47°C	ASTM A 350 Gr. LF3	A 320 Gr. L7	A 194 Gr. 7
-46° to -30°C	ASTM A 350 Gr. LF2	A 320 Gr. L7	A 194 Gr. 7
428° to 537°C	ASTM A 182 Gr. F11, F22	A 193 Gr. B16	A 194 Gr. 2H
538° to 648°C	ASTM A182 Gr. F11, F22	A 193 Gr. B8 Class 1	A 194 Gr. 8A
649° to 815°C	ASTM A182 Gr. F304 H, F316 H	A 193 Gr. B8M Class 1	A 194 Gr. 8A
-195° to 102°C	ASTM A 182 Gr. F304, F304L, F316, F316L, F321, F347	A320 Gr. B8 Class 2	A194 Gr. 8A

The material to use for stud bolts depends on multiple factors, the main ones are the material of the flanges and the pipeline design temperature:

Marking for Stud Bolts :

Stud bolts / Thread rods and nuts must be marked by the manufacturer with a unique identifier to identify the manufacturer (logo) or private label distributor, and grade symbol as appropriate.

STANDARD	MARKING (STUD BOLTS)			
ASTM A193/ A193M	Grade B7 	Grade B7M 	Grade B16 	
ASTM A320/ A320M	Grade L7 	Grade L7M 		
ASTM A193/ A193M ASTM A320/ A320M	Class 1  		Class 2  	
	Grade B8	Grade B8M	Grade B8	Grade B8M

OUR LOGO IS " GS " - GULF STUD .

Grades of Stud Bolts:

Below a table with materials and grades for flanges, thread rods (bolts) and nuts, arranged on design temperature, flanges, thread rods and recommended nuts.

DESIGN TEMP.	FLANGES	GRADE THREAD RODS	GRADE NUTS
-29° to 427°C	ASTM A105	A193 Gr.B7	A194 Gr.2H
-10° to 482 °C	ASTM A105*	A 193 Gr-B7M	A 194 Gr- 2HM
-101° to -47°C	ASTM A350 Gr.LF3	A320 Gr.L7	A194 Gr.7
-46° to -30°C	ASTM A350 Gr.LF2	A320 Gr.L7	A194 Gr.7
428° to 537°C	ASTM A182 Gr.F11, F22	A193 Gr.B16	A194 Gr.2H
538° to 648°C	ASTM A182 Gr.F11, F22	A193 Gr.B8 Class1	A194 Gr.8A
649° to 815°C	ASTM A182 Gr. F304H, F316H	A193 Gr.B8 Class1	A194 Gr.8A
-195° to 102°C	ASTM A182 Gr. F304, F304L, F316, F316L, F321, F347	A320 Gr.B8 Class2	A194 Gr.8A

Note: Materials in the table above are being provided for guidance purposes